Background Technical Details on Mandatory Interventions Used in Sodium Reduction Modelling for Cardiovascular Disease Prevention

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Summary of Interventions and Parameters

Intervention	Details	Key data inputs
Impacts		
Mandatory-3G: Mandatory reduction of sodium in the manufacture of breads, processed meats and sauces (the top 3 categories for sodium in NZ).	The principle of this approach is to follow the South African Government in mandating sodium levels in food (albeit with this law not yet implemented in late 2013). Based the relative contributions of sodium to the NZ diet (based on the NZANS and Total Diet Survey data) we estimated the impact of a hypothetical mandatory reduction of sodium in three groups of processed foods: breads, processed meats and sauces (i.e., the top three categories for sodium intake in New Zealand). A 25% reduction of sodium in each group was assumed to result from setting mandatory upper levels for sodium, giving a reduction in intake of 296 mg/d (12.9 mmol/d). This is a reduction of 8% of current intake for NZ adults.	Effect size: -12.9 mmol/d with SD at +/- 10% of this. Normally distributed.
Mandatory-All: Mandatory reduction of sodium in all processed foods to 25% of the current levels (food category averages).	Mandatory reduction of sodium in all processed foods by 25% of the current average levels (by setting product specific maximum levels). As for Intervention 3, NZANS and Total Diet Survey data were used in the estimates. The calculations considered all processed foods and excluded sodium intakes from: fresh fruit and vegetables, fresh fish and meat, and also salt added in cooking and at the table. The estimate obtained was a reduction of sodium intake of 525 mg/d or 22.8 mmol/d (equivalent to 1.4g/d of salt out of 9.1 g/d salt intake currently or 15% of current intake for NZ adults).	Effect size: -22.8 mmol/d with SD at +/- 10% of this. Normally distributed.

Intervention	Details	Key data inputs
Costs		
Mandatory-3G: Mandatory reduction of sodium in the manufacture of breads, processed meats and sauces (the top 3 categories for sodium in NZ).	For both of the mandatory interventions we used the cost of enacting a new law based on the average cost of new act in NZ[1] (with $NZ dollar values reported separately[2]). That is, the cost of a new law was estimated NZ$ 3,680,000 (in 2011 dollars). In scenario analyses we assumed that the laws for these two interventions would have a limited life (e.g., a sunset clause at 20 years) at which time we assumed that sodium levels in foods would revert to their pre-intervention levels. In the baseline model we assumed no significant changes to current evaluation efforts by the NZ Government (see further discussion in the *Methods Section*). Nevertheless, we did perform a scenario analysis that was based on Australian estimates that covered both legislative changes and on-going enforcement. That is used the NZ cost of a law plus added in half the cost of the Australian value (which covered by legislation and enforcement). That is half of $AUS 0.49 per person per year (gamma distribution, SE=$0.05). The Australian value is for the year 2008 (see supplementary information in Cobiac et al[3]) was derived from resource use estimates[4] and World Health Organization unit costs (www.who.int/choice/costs/en/).	Cost: $3,680,000. Gamma distribution with the SD of the being around 25% of the mean.
Mandatory-All: Mandatory reduction of sodium in all processed foods to 25% of the current levels (food category averages).	The same as per Intervention 3 (i.e., the cost of a new law, albeit with slightly different wording around the range of products covered).	As per the "Mandatory-3G" Intervention.

Dietary intake of sodium in New Zealand

Our analyses used the estimate of sodium intake from the NZ Adult Nutrition Survey – of 3544 mg/d.[5] Nevertheless, it is plausible that this level is somewhat low as an analysis of NutriTrack data for 2012 (N Wilson, unpublished) suggested a higher intake at around 3900 mg/day.

Our best current estimate of sodium sources was derived largely from national nutrition survey data, with some modification from other survey data. The values are detailed in

Table 1 below, along with our categorisation about this being included in the mandatory interventions (ie, involving processed food).

Table 1: Estimated sodium (and saturated fat) contribution by various food categories in the NZ diet

Food category	Sodium (%)*	% saturated fat intake (NZANS-08/09)	Categorisation for inclusion in the various mandatory interventions
Breads	20.59	2.3	Processed
Processed meats & sausages			
– Pork	7.74	2.5	Processed
– Poultry	3.5	1.08	Processed
– Beef	1.84	0.67	Processed
Potatoes and kumara	5.96	5.8	Processed
Sauces	5.61	1.4	Processed
Breakfast cereals	5.16	1.3	Processed
Meat and poultry (fresh, unprocessed)			
– Beef & veal	2.52	5	Not processed
– Poultry	2.22	5	Not processed
– Pork	1.26	2.5	Not processed
– Lamb/mutton	1.15	2.5	Not processed
Cakes, muffins and biscuits	8.36	10	Processed
Bread-based dishes	3.83	6.4	Mainly not processed**
Milk and dairy			
– Milk-whole	1.14	7.23	Not processed
– Milk-trim	1.27	0.37	Not processed
– (Other) dairy products	1.42	4.7	Processed
Butter and margarine			
– Butter	0.77	4.4	Processed
– Margarine	2.61	4.1	Processed
Pies and pasties	2.76	4	Processed
Cheese	2.49	6.3	Processed
Fruit and vegetables	5.5	3.8	Not processed
Non-alcoholic beverages (includes soft drinks)	0.89	1.7	Processed
Other	11.41	16.95	Mainly not processed**
Total#	**100**	**100**	

Notes:

* Derived from a previous national nutrition survey[6] but with updating from the "2009 New Zealand Total Diet Study" [NZTDS].[7] Additional data from the 2008/2009 New Zealand Adult Nutrition Survey [NZANS] [8] was used to make certain sub-divisions eg, for trim and whole milk.

** Although some of the foods in these categories are processed, we assumed that the interventions would be focused on more easily defined categories as per elsewhere in this table.

Intervention 3: Mandatory Intervention (25% reduction in 3 food groups)

We considered focusing on the three food groups of bread, processed meats and sauces as they have been the three most important for contribution of sodium to the NZ diet (analysis of National Nutrition Survey data 1997[6]). Historically, attempts to lower sodium levels in food have often concentrated on these groups (eg, from bread in NZ via the Heart Foundation and more recently processed meats). Indeed, there appears to be plenty of scope for reductions in sodium levels in these foods as per the data in Table 2 and Table 3 below.

Given the data in

Table 1, the hypothetical regulatory intervention of reducing the level of sodium in these three groups by 25% would result in an 8% reduction in sodium intake. But when adjusted by the assumption of 15% of sodium being from salt added during cooking or at the table (see Table 4), this was reduced slightly, giving a 296 mg/d reduction for the average adult (from the 3544 mg/d intake reported for NZ adults[5]). This reduction in impact was assumed to be the same in relative terms for men and women (ie, given the different baseline intakes[5]). But we assumed no variation by ethnicity (see Appendix 1).

Table 2: Results from analysis of NutriTrack data for 2012 for sodium in supermarket foods in NZ and comparison with another study

Food categories (specific products)	**Mean sodium (mg/100g)***	**SD**	**25th percentile**	**Another study of sodium levels** (mg / 100 g) by Woodward et al [9]	
				Mean sodium	**Minimum sodium**
Bread (n=120)	426.7	74.8	400	447 (SD=125)	186 (a multigrain bread)
Processed meats (n=526)	874	469.3	480	1169 (SD=444)	540 (a brand of sausage / and a brand of sliced meat) **
Sauces (n=715)	1583	1870.1	445	1046 (SD=1235)	170 (a brand of tomato sauce)

Notes:
* After removing 7 extreme outlier values that probably represent data collection errors in the NutriTrack compilation)
** For canned meats, even lower values are evident eg, 330 mg / 100g in a can of shredded chicken (with a Heart Foundation tick).

Table 3: Selected details on sodium levels (mg/100g) for processed meats and sauces based on NutriTrack data in 2012

	No. of products	Mean	SD	Minimum	25%	Median	Maximum
Processed meats							
Processed-beef	130	649	392	162	430	510	1960
Processed-chicken	150	580	320	115	347	500	2910
Processed-meat unclear	109	1281	443	62	910	1300	2100
Processed-pork	137	1086	339	150	934	1099	2210
Sauces							
Asian sauces	40	4929	1906	80	3535	5697.5	8000
Dressings	81	853	491	196	652	812	3800
Gravy	43	463	121	260	380	460	888
Marinades	20	1758	882	774	1224	1600	4408
Mayonnaise	45	672	175	263	608	675	985
Mustard	26	1813	907	280	1354	1663	4895
Pasta sauce	103	413	136	18	355	405	982
Sauce-dry	86	4143	2646	55	1780	4450	10144
Sauces	271	1234	1186	138	475	790	6448

Table 4: Overall pattern for sodium intake used in the modelling (based particularly on review work by McLean et al[10])

Source of sodium intake	% contribution	Notes
Sodium using in cooking and added at the table	15%	This was the figure used in the recent report on health loss by the NZ Ministry of Health.[11] It is fairly similar to the values found of in a USA study (11%),[12] in a UK study (11%),[13] in another UK study (12%),[14] in a Danish study (12%),[15] and in other UK work (10%).[16]
Sodium added to processed food and sodium naturally occurring in food	85%	This is the residual after considering the preceding row. For the distribution within this category, see the following table.
Sodium in drinking water	Ignored in our modelling	Is probably less than 1%.[12]

Intervention 4: Mandatory Intervention (25% reduction of sodium in all processed foods all)

This hypothetical intervention focused on salt reduction (by 25%) in all processed foods (as listed in Table 1). It made no assumptions about the particular mechanism –

but this could be via setting a maximum limit for within a food category (eg, maximum mg/100g for all breakfast cereals).

From the data in Table 1, this hypothetical regulatory intervention of reducing the level of sodium would result in a 15% reduction in sodium intake. But when adjusted by the assumption around some sodium being from salt added during cooking or at the table (see Table 4), this was reduced slightly, giving a 525 mg/d reduction for the average adult (from the 3544 mg/d intake reported for NZ adults). The same assumptions as per Intervention 3 were made as regards to sex and ethnicity.

Scenario analyses for the two mandatory interventions

We considered two scenario analyses:

- **Law expires.** We assume that benefit of the law requiring these mandatory interventions persists for 20 years and then expires (sunset clause). So at the 20 year point we assumed that all the sodium levels in food reverted to the pre-law levels, ie, intervention effect become zero at this point.

- **Inclusion of enforcement costs.** In the baseline model we assumed no significant changes to current evaluation efforts by the NZ Government (see further discussion in the *Methods Section* of the main manuscript). But in a scenario analysis we assumed some additional enforcement costs as per previous Australian work. That is, we used the NZ cost of a law plus added in half the per capita cost of the Australian value for enforcement costs (which covered by legislation and enforcement). This was half of $AUS 0.49 per person per year (gamma distribution, SE=$0.05). The Australian value is for the year 2008 (see supplementary information in this work[3]) and was derived from resource use estimates[4] and World Health Organization unit costs (www.who.int/choice/costs/en/).

Appendix 1: Sodium intake by ethnicity in New Zealand

The spot urine data from a sample of participants in the 2008/09Nutrition survey data reported no significant differences in sodium excretion by ethnicity.[5] This is probably the key measure – as it captures both sodium in processed foods consumed and sodium added in food preparation and at the table.

Nevertheless, there is evidence of higher occurrence of the addition of salt to food for both Māori men and women (compared to the NZ European/Other [NZEO] group) (Table A1 below). But the pattern for energy intake suggests no differences for the three food categories used in Intervention 3 (ie, bread, processed meats and sauces) for both Māori men and women (compared to the NZEO group) (Table A2 below). Māori men had more energy intake from some processed foods with added salt (eg, butter & margarine, pies and pasties) but less of others (breakfast cereals, biscuits and

cheese). Māori women had a lower intake of two groups of relatively high salt foods: breakfast cereals and cheese.

Of wider relevance to cardiovascular (CVD) health, it is of note that Māori had lower intakes of high potassium foods ie, fruit (males) and vegetables (males and females).

Table A1: Self-reported addition of salt to food after it has been cooked NZANS2008/09 data (online Excel tables: Use of salt (Excel, 72KB))

Population group	% Regularly/always adding salt (95%CI)
Māori men	47 (40, 54)
NZEO men	34 (30, 37)
Māori women	41 (36, 47)
NZEO women	27 (24, 31)

More detailed comments on food intake by ethnicity

Table A2 below shows that Māori men had no significantly different intakes of bread, processed meats and sauces compared to non-Māori men (the 3 major categories for contributing sodium covered in Intervention 3). But Māori men did have higher intakes of butter and margarine, pies and pasties, pork, eggs and egg dishes. Māori men had lower intake of fruit and vegetables (relevant for potassium intake), but also lower intake of breakfast cereals, biscuits and cheese (which are relevant for sodium intake).

Māori women had no significantly different intakes of bread, processed meats and sauces compared to non-Māori women (the 3 major categories for contributing sodium). Māori women did have higher intakes of non-alcoholic beverages and poultry (but the implications of these for sodium are unclear). But Māori women had lower intakes of vegetables (relevant for potassium intake), but also lower intake of breakfast cereals, and cheese (which are relevant for sodium intake).

Māori women were reported to consume more takeaway food (see Table A3) – but neither Māori males or females consumed more processed meat than the NZEO group (see Table A4).

Differences between Māori men and women were less marked. That is, Māori men had higher intakes of "pies and pasties" and of pork. Māori women had a higher intake of fruit and biscuits.

Differences between non-Māori men and women were also less marked. That is, non-Māori men had higher intakes of bread-based dishes. Non-Māori women had a higher intake of fruit, vegetables, and biscuits.

Table A2: Energy intake from differing food groups for different sex/ethnicity groupings (as a % of total energy intake). Results are not age-adjusted, and are shaded for significantly higher levels when comparing ethnic groups (comparing confidence intervals for Māori males vs non-Māori males). Values in bold italics are for statistically significant differences by sex with ethnic groups (ie, comparing Māori males vs Māori females). Data source: NZANS 2008/09, "A Focus on Maori Nutrition" http://www.health.govt.nz/publication/focus-maori-nutrition

Food Group (shaded and bold are those including in the "Mandatory-All" reduction intervention – ie, Intervention 4)	**Māori males (%, 95%CI)**	**Non-Māori males (%, 95%CI)**	**Māori females (%, 95%CI)**	**Non-Māori females (%, 95%CI)**
Bread	12.5 (11 - 14)	11.3 (10.6 - 12)	10.9 (10 - 11.9)	10.6 (9.9 - 11.2)
Grains & pasta	4.8 (3.6 - 5.9)	7.2 (6.3 - 8.1)	4.9 (4.1 - 5.7)	6.8 (6.1 - 7.5)
Potatoes, kumara & taro	7.6 (6.6 - 8.7)	6.2 (5.6 - 6.8)	7.5 (6.5 - 8.5)	6 (5.4 - 6.7)
Fruit	2.8 (2.2 - 3.4)	4.5 (4 - 4.9)	***5.6 (4.6 - 6.7)***	***6.3 (5.9 - 6.8)***
Non-alcoholic beverages	6.1 (4.8 - 7.5)	4.9 (4.4 - 5.3)	6.7 (5.7 - 7.7)	4.8 (4.4 - 5.2)
Milk	4.1 (3.5 - 4.8)	4.8 (4.4 - 5.1)	5.2 (4.7 - 5.8)	5.2 (4.8 - 5.6)
Bread based dishes	6.5 (4.2 - 8.7)	***6.2 (5.2 - 7.2)***	5.2 (4 - 6.4)	3.9 (3.3 - 4.5)
Alcoholic beverages	4.5 (3.1 - 5.8)	5.9 (5.2 - 6.7)	3.1 (2.2 - 3.9)	4.5 (3.8 - 5.2)
Sugar & sweets	3.9 (3.2 - 4.7)	4.2 (3.8 - 4.6)	4.7 (3.9 - 5.5)	4.3 (3.8 - 4.7)
Poultry	3.6 (2.6 - 4.6)	3.7 (3.1 - 4.3)	5.1 (4 - 6.2)	3.5 (3 - 3.9)
Vegetables	2 (1.6 - 2.5)	3.2 (2.9 - 3.5)	2.8 (2.3 - 3.3)	***4.6 (4.1 - 5)***
Cakes & muffins	2.1 (1.3 - 3)	3.5 (2.9 - 4.1)	3.6 (2.5 - 4.7)	4.2 (3.6 - 4.7)
Breakfast cereals	2.3 (1.7 - 2.9)	3.7 (3.2 - 4.2)	2.5 (1.9 - 3.1)	3.6 (3.2 - 4)
Beef & veal	3.9 (2.9 - 4.9)	3.4 (2.9 - 4)	3.5 (2.7 - 4.2)	3 (2.6 - 3.4)
Butter & margarine	4.1 (3.5 - 4.7)	3 (2.7 - 3.2)	3.5 (3 - 4.1)	2.8 (2.6 - 3.1)
Fish & seafood	3.7 (2.5 - 4.8)	2.5 (2 - 3)	2.7 (1.9 - 3.6)	2.7 (2.3 - 3.2)
Biscuits	1.2 (0.8 - 1.6)	2.4 (2.1 - 2.7)	***2.6 (2 - 3.2)***	***3.2 (2.8 - 3.5)***
Pies & pasties	***6 (4.4 - 7.6)***	2.7 (2.1 - 3.2)	3.2 (2.4 - 4.1)	1.9 (1.4 - 2.4)
Dairy products	1.6 (1.1 - 2.2)	2.3 (1.9 - 2.7)	2.5 (1.9 - 3)	2.8 (2.4 - 3.2)
Sausages & processed meats	3.1 (2.1 - 4.2)	2.3 (1.8 - 2.7)	3 (2.1 - 3.8)	2 (1.7 - 2.4)
Cheese	1 (0.7 - 1.3)	1.9 (1.6 - 2.2)	1.4 (1.1 - 1.7)	2.2 (1.9 - 2.5)
Pork	***3.2 (2.3 - 4.1)***	1.9 (1.5 - 2.2)	1.7 (1.2 - 2.2)	1.4 (1.2 - 1.7)
Eggs & egg dishes	2.5 (1.8 - 3.2)	1.3 (1.1 - 1.5)	1.9 (1.5 - 2.4)	1.5 (1.2 - 1.7)
Savoury sauces & condiments	1.2 (0.9 - 1.5)	1.2 (1 - 1.4)	1.2 (0.9 - 1.4)	1.6 (1.4 - 1.8)
Nuts seeds	1 (0.6 - 1.4)	1.1 (0.8 - 1.4)	0.7 (0.4 - 0.9)	1.4 (1.1 - 1.7)
Lamb & mutton	1.4 (0.6 - 2.1)	1 (0.6 - 1.3)	0.8 (0.5 - 1.2)	1 (0.7 - 1.3)
Puddings & desserts	0.6 (0.2 - 1)	1 (0.7 - 1.3)	1 (0.6 - 1.4)	1 (0.8 - 1.3)
Soups & stocks	0.4 (0 - 0.8)	0.6 (0.4 - 0.8)	0.9 (0.3 - 1.4)	1.1 (0.8 - 1.3)
Snack bars	0.6 (0.2 - 1.1)	0.8 (0.6 - 1)	0.6 (0.3 - 0.8)	0.7 (0.5 - 0.9)
Snack foods	0.8 (0.3 - 1.2)	0.5 (0.3 - 0.7)	0.6 (0.4 - 0.9)	0.7 (0.5 - 1)
Fats & oils	0.1 (0 - 0.2)	0.3 (0.2 - 0.4)	0.2 (0.1 - 0.3)	0.4 (0.3 - 0.5)
Dietary supplements	0.5 (0.1 - 1)	0.2 (0.1 - 0.4)	0.1 (0 - 0.2)	0.2 (0.1 - 0.3)
Other meat	0 (0 - 0)	0.2 (0.1 - 0.4)	0.1 (0 - 0.1)	0.1 (0.1 - 0.2)

Table A3: Consumption of pre-prepared foods, Māori, by sex ("A Focus on Maori Nutrition" – Report based on the NZANS2008/09). Results shaded where there is a statistically significant difference with non-Māori.

Frequency of consumption of pre-prepared foods	Sex	Māori (95% CI)	Māori compared with non-Māori (standardized to World Population)	
			Difference	Ratio
Eat fast food or takeaways 3 or more times a week (%)	Males	10.1 (6.8–13.5)	–0.3	0.97
	Females	11.2 (8.3–14.1)	7.2*	3.01*
Eat fast food or takeaways 1–2 times a week (%)	Males	39.8 (33.2–46.5)	4.6	1.14
	Females	34.5 (29.4–39.7)	6.6*	1.24
Eat fast food or takeaways less than once a week or never (%)	Males	50.0 (44.2–55.8)	–4.4	0.92
	Females	54.3 (49.3–59.3)	–13.8*	0.80*
Eat hot chips 3 or more times a week (%)	Males	14.5 (10.1–18.9)	0.7	1.05
	Females	12.6 (9.7–15.4)	8.1*	3.16*
Eat hot chips 1–2 times a week (%)	Males	48.0 (42.0–54.1)	4.2	1.10
	Females	39.3 (34.3–44.2)	6.9*	1.21*
Eat hot chips less than once a week or never (%)	Males	37.4 (31.5–43.4)	–4.8	0.89
	Females	48.2 (43.0–53.3)	–14.9*	0.77*

Table A4: Frequency of eating processed meat, Māori, by sex. Results shaded where there is a statistically significant difference with non-Māori.

	Sex	Māori (95% CI)	Māori compared with non-Māori (standardised to World Population)	
			Difference	Ratio
Eats processed meat 3 or more times a week (%)	Males	45.2 (38.6–51.9)	6.8	1.19
	Females	26.7 (21.9–31.5)	2.5	1.11
Eats processed meat 1–2 times a week (%)	Males	39.8 (33.1–46.5)	0.2	1.00
	Females	44.2 (38.7–49.8)	3.9	1.09
Eats processed meat less than 1 time a week / never eats processed meat (%)	Males	14.9 (10.8–19.1)	–7.0*	0.70*
	Females	29.0 (24.1–34.0)	–6.4*	0.82*

Appendix 2: Background information on NZ population sodium intake data

Table A5: Data from the 2008/2009 NZ Adult Nutrition Survey (NZANS) was used.[5]

Sex/age-group	Sodium excreted in urine/day (mg)	Standard deviation (mg)	Māori & NZ European/Other	Mmol of sodium**
Men				
15-18	3764	2680	No significant difference – so we used the values for "all men" for both groups#	164
19-24	4382	1979		191
25-44	4238	1950		184
45-64	3956	1947		172
65+	3532	3920		154
Women				
15-18	2861	2308	As above (for all women)	124
19-24	2835	1324		123
25-44	3402	1856		148
45-64	3073	1905		134
65+	2841	3637		124

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